REMARKS/ARGUMENTS

The above identified patent application has been amended and reconsideration and reexamination are hereby requested.

Claims 1-6 are now pending in the application. Claims 1-6 have been amended.

Claim Objections

The Examiner has objected to Claim 2-5 because of informalities. As requested by the Examiner, the Applicant has replaced "A" with "The" in Claims 2-5. In addition, "shared boundaries" in Claim 4 now has proper antecedent basis.

In view of the above amendments, it is respectfully requested that the above objections be withdrawn.

Claims Rejections - 35 U.S.C. § 102

The Examiner has rejected Claims 1-6 under 35 U.S.C. § 102(b) as being anticipated by Andreev et al. (US Patent Publication No. US 2001/0018759).

The amended Claim 1 includes (underlining added for emphasis) "A method of determining the routing of interconnected regions of a routing problem by considering all required connections in parallel independently and attempting to resolve crossing conflicts only when at least some contextual information about a region and the paths that cross in the region has been assembled." The amended Claim 6 includes (underlining added for emphasis) "A computer-implemented method of determining the routing of interconnected regions of a routing problem, the interconnected regions being regions of an electrical circuit, by considering all required connections in parallel independently and attempting to resolve conflicts only when at least some contextual information about a region and the paths which cross there has been assembled." The Applicant submits that Andreev et al. does not teach the above limitations.

The invention described in our (Zuken's) patent application 10/672186 *is* new, because it describes a method of routing all required connections in parallel independently - *all* connections, not just those which don't overlap. This 'independence', or symmetry, allows *all*

nets to be routed simultaneously, and is what distinguishes our invention from all previous patents, including the Andreev patent US 2001/0018759.

In this response we shall show (1) that independence is not anticipated by either the claims or the technical details of the Andreev patent; (2) that the Andreev algorithm cannot be adapted to support independence; and (3) that the Greene algorithm supports independence.

(1) No independence in Andreev

Consider the Office Action in reference to Zuken's Quantum Router patent from Daniel C Murray of the US Patent and Trademark Office dated '09/21/2007' (i.e., 2007-09-21). On page 3 of the Office Action, section 6 a) states that

> ... Andreev et al. clearly show and disclose, a method ... considering *all* required connections *in parallel* (figure2 [sic], figure 3, abstract, paragraph [0033], paragraph [0034], paragraph [0088], paragraph [0091], paragraph [0096]) ...

This is, strictly speaking, incorrect. Andreev in fact only discloses a method of routing all required connections in parallel *when they don't overlap each other*, not a method of routing *all* connections in parallel independently and simultaneously.

The phrase 'in parallel' in the Andreev patent is being used to mean 'in parallel except where it's obviously not possible', and the Examiner has read it to mean 'in parallel independently', which it certainly does not. Compare the word 'simultaneously', which is used correctly and literally in the Andreev patent, and is always qualified by the word 'substantially' (e.g., see Andreev's **abstract**).

Paragraph [0216] of Andreev clearly says that the algorithm described

> 'make[s] sure that the nets worked on simultaneously are not in the same area',

that is, that overlapping nets cannot be handled in parallel simultaneously because of their interdependence. This paragraph, and the following two paragraphs **[0217]** and **[0218]**, clearly distinguish Andreev's algorithm from Greene's.

Note that Andreev describes several distinct algorithms (splitting large nets, finding spanning trees, routing, etc.), and many of these *can* be run in parallel. For example, one large net may be split into smaller subnets quite independently from a different large net being split into *its* smaller subnets, so these tasks may be performed in parallel with no interaction. The point is that the routing part of the algorithm *cannot* be truly parallel, and this is part of the novelty in the Greene patent.

(1a) Supposed supporting 'evidence' for Andreev simultaneity

The examiner cites the following sections as 'evidence' for Andreev's ability to route nets 'in parallel'. They only show that the Andreev routing algorithm routes nets 'in parallel where they don't overlap', not actually in parallel, or 'in parallel independently'.

Andreev's **abstract** says that their patent protects

> 'A method for ... routing nets ... with parallel processors operating substantially simultaneously ...'

and this is the first admission of the essential difference between Andreev and Greene; the processors only operate *substantially* simultaneously, and the routing is not actually fully in parallel or simultaneous.

Paragraph [0033] says

'routing nets ... with parallel processors operating substantially simultaneously'

correctly echoing this distinction.

Figure 2 skims over this subtlety, since box 4 says

'Route nets in parallel.'

whereas it should, according to the **abstract** and **paragraph [0033]**, say 'route nets substantially in parallel', or, according to **paragraph [0216]** and following, say 'route nets in parallel as much as possible' or 'route nets in parallel where they don't overlap'.

Figure 3 does not say how the connections are considered, whether in parallel or not.

Paragraph [0034] is about constructing the routing, and does not touch on simultaneity.

Paragraph [0088] says

'Described in this Section ... is a system for routing an integrated circuit in parallel'

but as we shall see this is only mostly the case. In fact, Andreev gives a system for routing an integrated circuit *substantially* in parallel, as the **abstract** makes clear.

Paragraph [0091] says that step 4 in Figure 2 is

'to route the nets in parallel'

but it refers the reader to Section IV for details. This is inconsistent with the **abstract**, since again the description of the algorithm has been simplified for verbal convenience, and also inconsistent with Section IV; it should be saying that step 4 is 'to route the nets substantially in parallel', as Section IV actually describes.

Paragraph [0096] is the first mention of the 'Locking Mechanism'. When a particular net is under consideration, this mechanism stops other nets from looking in or interacting with the same region of the board. That is, this locking mechanism is precisely to prevent all nets from being considered simultaneously! Although the paragraph says

> 'Since an object of the present invention is to allow the parallel routing of nets, this mechanism can be utilized [sic] throughout the system as a memory-efficient means of parallel processing the routing.'

what it means is that the object of the present invention is to allow the parallel routing of nets *wherever possible*, or *where they don't overlap*. This is again presumably for verbal convenience; the phrase 'in parallel' is being used to mean 'in parallel except where it's not possible'. The locking mechanism enforces this.

(1b) Evidence that Andreev does not, in fact, support independence

We list some direct evidence showing that Andreev's routing algorithm is not truly independent, that is, that it is not capable of routing *all* nets in parallel simultaneously.

The **abstract** says 'parallel processors operating substantially simultaneously'.

Figure 18, box 76, says

'Route nets in parallel. As soon as a net is routed, its projected occupancy is replaced with the actual one and the affected penalties are recalculated'

But if the nets are being routed truly independently, there would be no point in updating occupancies or penalties, because all other nets are being processed at the same time! The fact that the Andreev algorithm *does* update these - because this net has 'locked' an area of the board so no other nets can be being routed inside it at the same time - shows that their routing algorithm is not, and cannot be, simultaneous, since the routing of one net depends on the routing paths chosen by previous nets.

Figure 25 shows an outline of the locking mechanism algorithm enabling nets to lock regions of the board. When a region is locked, other nets in that region cannot be processed. So the algorithm is not fully simultaneous, only 'substantially simultaneous' as stated in the **abstract,** and does not literally route the nets 'in parallel'.

Paragraph [0033] correctly uses the phrase 'substantially simultaneously' to describe the routing algorithm in the patent.

Paragraph [0085] refers to **Figure 25**, the locking mechanism.

Paragraph [0096] refers to the locking mechanism directly.

Paragraph [0206] describes in more detail how occupancies are updated 'as nets are routed', which of course makes no sense if they are being routed independently.

Paragraph [0209] describes the same for penalties.

Paragraphs [0216] to **[0218]** state explicitly that their algorithm is not, and cannot be, fully simultaneous, since the nets cannot, in fact, be routed in parallel independently. **Paragraph [0216]** is the nub, saying

> 'we need to make sure that while working in parallel we never need to adjust the same edge at the same time.'

This is a direct admission that the algorithm described cannot handle all nets in parallel independently, since any two which overlap the same area must be handled (at least partly) serially, and the routing chosen for one may affect the routing chosen for the other..

Paragraph [0217] describes the serial part of their algorithm in more detail. In particular, it specifically says that

> 'The nets with the characteristic larger than 1/4 we route sequentially.'

It goes on to describe how nets with smaller 'characteristic' (roughly, 'size') are grouped into packets and split between processors, but notice that overlapping nets are never processed simultaneously because of their interdependence.

Paragraph [0218] continues this description, but it is only at this point that

> 'we can include more processors to speed up the routing process'

i.e., up to this point, the routing part of the algorithm has been mainly serial.

(2) Andreev routing cannot be independent

The Andreev routing algorithm cannot be adapted to handle all nets independently. A reader knowledgeable in routing algorithms could not, using this algorithm as a basis, adapt it to route all nets in parallel. The basic operation of the algorithm requires occupancies and the corresponding penalties to be written to the edges in the graph representing the routable area, and these values cannot be accessed by more than one net at a time. **Paragraph [0216]** says

> 'we need to make sure that while working in parallel we never need to adjust the same edge at the same time.'

This explicitly states that the Andreev routing algorithm cannot route all nets in parallel simultaneously, since any two which want to adjust the same edge area must be routed serially. The paragraph goes on to say that

> 'The easiest way to do that is to make sure that the nets worked on simultaneously are not in the same area.'

and outlines an approach which enforces this. That is, the approach in **paragraphs [0217]** and **[0218]** is not the only way of stopping edges be accessed simultaneously; but some such mechanism *is required* to get round the interdependence of overlapping nets' routing.

The routing chosen for a net is as cheap as possible given the penalties currently on edges it must cross. When a net is routed, the edge occupancies are updated (see **paragraph [0206]**) to reflect the chosen route. This of course affects the routing choices of subsequent nets. So from the point of view of an individual edge, the nets which may cross it *must* be routed serially, since one net cannot be changing the edge's occupancy while another is trying to read it.

Suppose Andreev's algorithm *was* changed to consider all nets independently. This will inevitably lead to problems. As an example, suppose two nets A and B are being routed

independently and two edges E0 and E1 have projected occupancy of 0.5 from both nets. E0 currently has a lower penalty than E1, but if either net is routed across E0, E0 will then have a higher penalty than E1. Since the nets are being routed independently, we don't know which will be considered first, and a race condition can occur. If A is routed first, A will bag the cheaper E0, and B will be left to go across E1. If B is routed first, B will bag the cheaper E0, and A will only be left the more expensive E1. But if they happen to be routed simultaneously, A and B may both read the penalty values at the same time, may *both* decide to cross E0, and will both grab the first edge, which may in fact not be wide enough to accommodate both routes at once, leading to invalid routing.

This simple example shows that Andreev's routing algorithm is fundamentally non-symmetric and non-simultaneous (even though it *is* 'substantially simultaneous'), and cannot, strictly speaking, lay claim to being able to route *all* nets *in parallel.*

(3) Greene's routing algorithm supports independence

The Greene routing algorithm, by contrast, considers all nets entirely independently, and could be entirely simultaneous. All nets may be routed in parallel, independently , simultaneously, and symmetrically. Consider Greene's **Figure 1**, the triangle example. Since these three nets overlap, they will be considered serially in Andreev's algorithm; but Greene cites this example precisely because there are many pre-existing routers which can consider such routing problems serially but only Greene's algorithm which can consider the nets in parallel simultaneously.

With reference to **figure 2**, Greene's text says (my italics)

> '(ii) Route each connection 21. This step is a fine-tuned flood search algorithm, stepping from one polygon to the next, attempting to find a permissible route for each connection *considered in isolation.*'

That is, each connection (the Greene equivalent of Andreev's 'net') may be considered 'in isolation', independently of all others, even those which overlap it. The novelty in the Greene algorithm is to split the individual routing of the nets, which may be performed completely in parallel, from the construction and resolution of conflicts, which may also be performed completely in parallel. Each of these two basic blocks of the algorithm needs to have finished before the next block can start; but within each block complete simultaneous parallelism is possible. Andreev's routing is interleaved with penalties (loosely corresponding to Greene's conflicts), and these cannot be split apart to allow full independence in the routing step.

Claim 1 in Greene says (my italics)

> 'A method of determining the routing ... by considering all required connections *in parallel*'

By 'in parallel', Greene literally means in parallel, that is, all connections in parallel, simultaneously, independently, and symmetrically. This contrasts with Andreev's use of the phrase 'in parallel', which, as we have seen, actually means 'in parallel where possible (which is most of the time)'.

Claim 3(b) says (my italics)

> 'collating all such proposed routing and resolving any conflicts *in a symmetric manner*'

showing that the resolution of conflicts is also symmetric, i.e. independent of order, so this block is also possible completely in parallel.

Claim 6 also says (my italics)

'A .. method of determining the routing ... by considering all required connections *in parallel*'

echoing **Claim 1**. Again, 'in parallel' is being used literally.

Accordingly, the Applicant submits that Claims 1 and 6 are not anticipated by Andreev et al. under 35 U.S.C. § 102(b). Claims 2-5 are dependent on Claim 1 and therefore include all of the limitations of Claim 1 and additional limitations therein. As such, these claims are also allowable based upon Claim 1 and the additional limitations therein.

Therefore, in view of the above amendment and remarks, the Applicant respectfully submits that the claims are patentably distinct over the prior art and that all the rejections to the claims have been overcome. As such, allowance of the above Application is requested. If there are any remaining issues that can be addressed over the telephone, the Examiner is cordially invited to call the Applicant's attorney at the number listed below.

Respectfully submitted,
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